
Introduction to the Federal Radionavigation Plan

This section describes the background, purpose, and scope of the Federal Radionavigation Plan (FRP). It summarizes the events leading to the preparation of this document and the national objectives for coordinating the planning of radionavigation services. The remaining contents of Section 1 set forth national policy, radionavigation authority and responsibility, and radionavigation system planning.

1.1 Background

The first edition of the FRP was released in 1980 as part of a Presidential Report to Congress, prepared in response to the International Maritime Satellite (INMARSAT) Act of 1978. It marked the first time that a joint Department of Transportation (DOT) and Department of Defense (DOD) plan for common-use (both civil and military) systems had been developed. Now, this biennially-updated plan serves as the planning and policy document for all present and future Federally provided common-use radionavigation systems. This edition also reflects input obtained at the radionavigation user conferences held in 1993.

The 1979 DOD/DOT Interagency Agreement for joint radionavigation planning, as well as for the development and publication of the FRP, was renewed in 1990. This agreement recognizes the need to coordinate all Federal radionavigation system planning and to attempt, wherever consistent with operational requirements, to utilize common systems. A memorandum of agreement between the DOD and DOT on the civil use of the Global Positioning System (GPS) signed in January 1993 established

policies and procedures to ensure an effective working relationship between the two Departments regarding the civil use of GPS.

Since the publication of the first edition of the FRP, there have been significant changes in the radionavigation environment. A Joint DOD/DOT Task Force on GPS report to the Secretaries of Defense and Transportation, dated December, 1993, recommended the creation of a GPS Executive Board, composed of an Assistant Secretary from each Department. The purpose of the Board was to resolve conflicts arising from joint civil and military use of GPS. The report also recommended assignment of radionavigation policy and planning responsibilities to a DOT Assistant Secretary and establishment of a DOT Positioning and Navigation (POS/NAV) Executive Committee within DOT to mirror a similar organization within DOD. The report was accepted by both Secretaries. The new POS/NAV management structure is shown in Figure 1-1. In a memorandum dated May 18, 1994, the Secretary of Transportation transferred the radionavigation oversight function to the Assistant Secretary for Transportation Policy (OST/P).

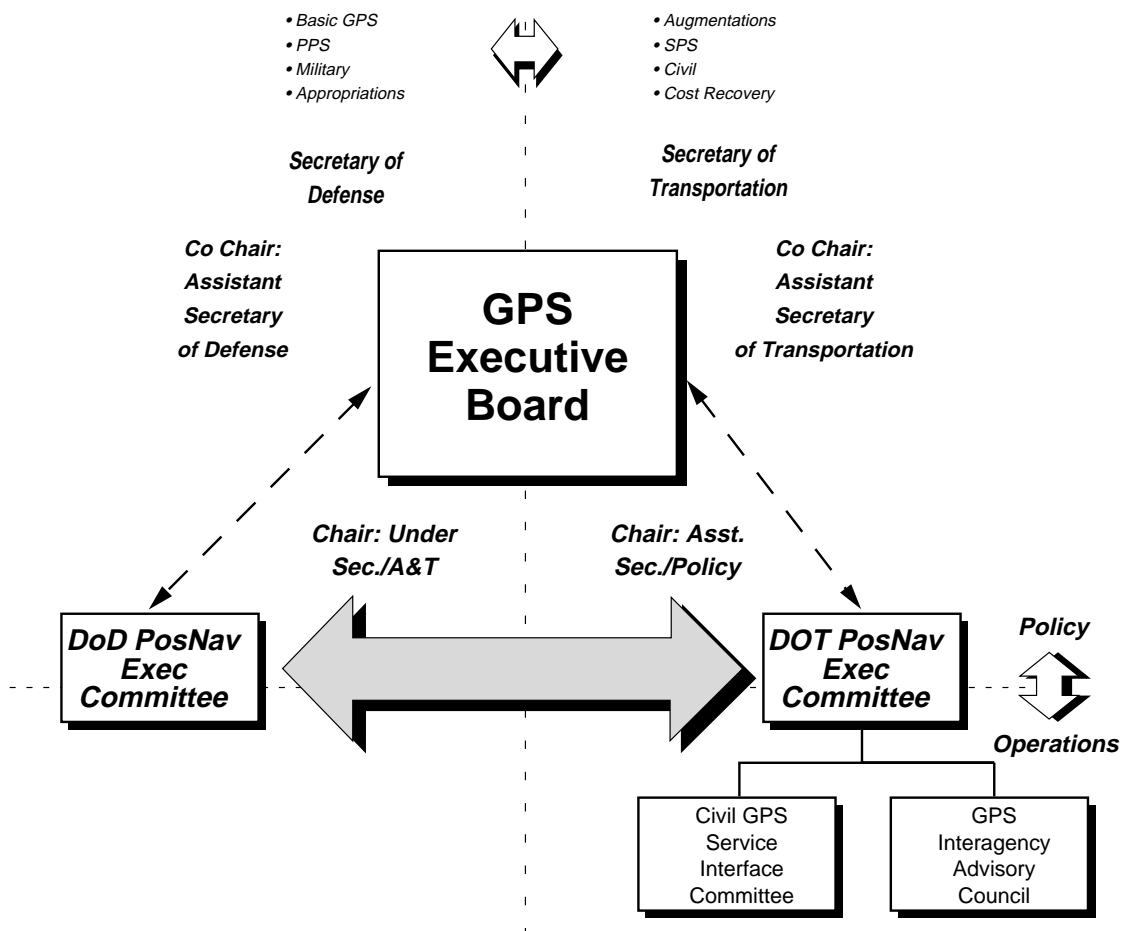


Figure 1-1. Joint DOD/DOT POS/NAV Management Structure

Although GPS is a principal driving force in the FRP, other external factors such as breakthroughs in technology, reductions in receiver costs, marketplace pressures, and increasing private sector involvement have affected the evolution of the FRP.

In 1990, the FRP began expanded discussions of land uses of radionavigation systems. This was driven primarily by a recognition of the use of systems such as GPS and Loran-C in land transportation applications. The 1994 FRP continues to update discussions on land applications, including the extensive use of radionavigation systems for positioning, surveying, timing, weather research, and many other applications.

The Federal Government holds open meetings every two years to provide the user community with the opportunity to comment on Federal radionavigation system policies and plans. The 1993 radionavigation user conferences were held on November 9-10 in Washington, D.C.; on November 30 in Columbus, Ohio; and on December 2 in Seattle, Washington.

Comments from the users indicated strong support for use of the GPS by the civil community. There appears to be a preference among users for some level of nationwide standardization of differential GPS (DGPS) services to avoid proliferation of different data formats and transmission media. There is also a strong trend of increasing use of GPS for non-navigation purposes, such as positioning, surveying, and timing, among government agencies and private industry.

Representatives from the Loran-C and Omega communities recommended that promoting the competitiveness of the U.S. radionavigation manufacturers should be a stated Federal policy. Important steps in fulfilling this objective include close cooperation between manufacturers and government.

The air transport industry strongly supports a near-term transition to GPS-based navigation and landing systems in the National Airspace System (NAS). The general aviation community and state aviation authorities support timely, well-proven implementation of GPS and Loran-C approaches to meet the need for more instrument approaches at airports currently lacking such capability. The aviation community also desired clarification of the Microwave Landing System (MLS) policy.

The United States Coast Guard (USCG) stated that the planned phase-out periods for Loran-C and Omega are being revisited due to the expected high user equipage with GPS. These statements resulted in numerous requests from the user community to retain the transition periods that are stated for these two systems in the 1992 FRP.

Many users stated concerns with having to rely on one navigation system and felt that safety dictated the availability of alternative systems.

The need to consolidate and reduce the number of systems is a major objective of DOD and DOT. The constantly changing radionavigation user profile and rapid

advancements in systems technology require that the FRP remain as dynamic as the issues addressed. The current DOD/DOT policy on the radionavigation systems mix is presented in Section 1.6.

1.2 Purpose

The purpose of the FRP is to:

- ◆ Present an integrated Federal policy and plan for all common-use civil and military radionavigation systems.
- ◆ Provide a document for specifying radionavigation requirements and addressing common-use systems and applications.
- ◆ Outline an approach for consolidating radionavigation systems.
- ◆ Provide government radionavigation system planning information and schedules.
- ◆ Define and clarify new or unresolved common-use radionavigation system issues.
- ◆ Provide a focal point for user input.

1.3 Scope

This plan covers Federally provided, common-use radionavigation systems, acknowledging that these systems can be used for other purposes. It also briefly addresses privately owned systems such as Radar Transponder Beacons (RACONs), and others that interface with or impact Federally provided systems. The plan does not include systems which mainly perform surveillance and communication functions.

The major systems subject to the planning process described in this FRP are:

- | | |
|------------------------|----------------|
| ◆ GPS | ◆ ILS |
| ◆ Augmentations to GPS | ◆ MLS |
| ◆ Loran-C | ◆ Transit |
| ◆ Omega | ◆ Radiobeacons |
| ◆ VOR and VOR/DME | ◆ VTS |
| ◆ TACAN | |

Augmentations to GPS, such as DGPS, are enhancements to the GPS system. Because of their unique characteristics, these augmented systems are addressed separately in this document.

Transit, a satellite-based radiodetermination system, is discussed because of its use in marine navigation.

Vessel Traffic Services (VTS) are also discussed, because DGPS is an essential component of the system being installed at Valdez, Alaska, and has the potential for use in future VTS.

1.4 Objectives

The radionavigation policy of the United States has evolved through statute, usage, and in the interest of national defense and public safety. The objectives of U.S. Government radionavigation system policy are to:

- ◆ Support national security.
- ◆ Provide safety of travel and promote environmental protection.
- ◆ Promote efficient transportation.
- ◆ Support national positioning and timing requirements.

1.5 Policies and Practices

The following U.S. Government policies and practices support the above objectives:

- a. Implementation and operation of radio aids to navigation. Services which contribute to safe, expeditious, and economic air, land and maritime commerce and which support United States national security interests are provided.
- b. Installation and operation of radionavigation systems in accordance with international agreements.
- c. Avoidance of unnecessary duplication of radionavigation systems and services. The highest degree of commonality and system utility between military and civil users is sought through early consideration of mutual requirements.
- d. Recognition of electromagnetic spectrum requirements in the planning and management of radionavigation systems.
- e. Promotion of transportation safety and environmental protection by requiring certain vessels and aircraft to be fitted with radionavigation equipment as a condition for operating in the controlled airspace or navigable waters of the United States.

- f. Direction to ensure that radionavigation services available to civil users meet projected demand, performance, safety, and environmental protection requirements considering economic constraints on radionavigation system providers and users.
- g. Evaluation of domestic and foreign radio aids to navigation, with support for the development of those systems having the potential to meet unfulfilled operational requirements; those offering major economic advantages over existing systems; and those providing significant benefits in the national interest.
- h. Establishment of a suitable transition period based on user equipment and acceptance, budgetary considerations, and the public interest.
- i. Promotion of international exchange of scientific and technical information concerning radionavigation aids.
- j. Guidance and assistance in siting, testing, evaluating, and operating non-Federal and private radio aids to meet unique aviation requirements.
- k. Promotion of national and international standardization of civil and military radionavigation aids.
- l. Establishment, maintenance, and dissemination of system and signal standards and specifications.
- m. Development, implementation, and operation of the minimum special radionavigation aids and services for military operations.
- n. Operation of common-use radionavigation systems as long as the United States and its allies accrue greater military benefit than potential adversaries. Operating agencies may cease operations or change characteristics and signal formats of radionavigation systems during a dire national emergency, as declared by the National Command Authority (NCA).
- o. Provision of the GPS Standard Positioning Service (SPS) for continuous, worldwide civil use at the highest level of accuracy consistent with U.S. national security interests.
- p. Implementation of the Global Positioning System as the world's standard in the air, on land, and over water.
- q. Enhancement of GPS for civil applications.
- r. Equipping of military vehicles, as appropriate, to satisfy civil aviation and maritime navigation safety requirements. However, the primary concern will be that U.S. military vehicles and users are equipped with navigation systems which best satisfy mission requirements. Standardization, although important, may be

disregarded when unique military systems provide the capability to operate safely without reference to civil radionavigation systems.

- s. Establishment of mechanisms, where practical, for users of Federally provided radionavigation systems to bear their fair share of the costs (except for direct charges for basic GPS signals) for development, procurement, operation, and maintenance of these systems.
- t. Provision, through DOD/DOT interagency agreements, of comprehensive management for all Federally provided common-use radionavigation systems.
- u. Ensuring, in accordance with the national policy found in OMB Circular A-76, that the private sector is considered in the design, development, installation, operation, and maintenance of all equipment and systems required to provide common-use radionavigation aids in support of this FRP (within the constraints of national security).

1.6 DOD/DOT Policy on the Radionavigation System Mix

The Department of Transportation is responsible under 49 United States Code (U.S.C.) 301 for ensuring safe and efficient transportation. Radionavigation systems play an important role in carrying out this responsibility. The two main elements within DOT that operate radionavigation systems are the USCG and the Federal Aviation Administration (FAA). The Assistant Secretary for Transportation Policy (OST/P) is responsible for coordinating radionavigation planning within DOT and with other civil Federal elements.

The USCG provides U.S. aids to navigation for safe and efficient marine navigation. The FAA has the responsibility for the development and implementation of radionavigation systems to meet the needs for safe and efficient air navigation, as well as for control of all civil and military aviation, except for military aviation needs peculiar to warfare and primarily of military concern. The FAA also has the responsibility to operate aids to air navigation required by international treaties.

Other elements within DOT participate in radionavigation planning. These elements include the St. Lawrence Seaway Development Corporation (SLSDC), the Maritime Administration (MARAD), the Office of Commercial Space Transportation (OCST), the Federal Highway Administration (FHWA), the Federal Railroad Administration (FRA), the National Highway Traffic Safety Administration (NHTSA), the Federal Transit Administration (FTA), the Research and Special Programs Administration (RSPA), the Bureau of Transportation Statistics (BTS), and the Intelligent Transportation Systems Joint Program Office (ITS-JPO).

The Department of Defense is responsible for developing, testing, evaluating, implementing, operating, and maintaining aids to navigation and user equipment

required for national defense and ensuring that military vehicles operating in consonance with civil vehicles have the necessary navigational capabilities.

All common-use systems operating or planned were considered in developing the policy on the mix of Federally provided radionavigation systems. The statement that follows is the DOD/DOT radionavigation policy.

Federal Policy and Plans for the Future Radionavigation Systems Mix (1994 Federal Radionavigation Plan)

Purpose: This statement sets forth the policy and plans for Federally provided radionavigation systems.

Objectives: The Federal Government operates radionavigation systems as one of the necessary elements to enable safe transportation and encourage commerce within the United States. It is a goal of the Government to provide this service in a cost-effective manner. In order to meet both civil and military radionavigation needs, the Government has established a series of radionavigation systems over a period of years. Each system utilizes the latest technology available at the time of introduction to meet existing or unfulfilled needs. This statement addresses the conditions under which each system will be part of the Federal radionavigation systems mix.

The Department of Defense (DOD) has deployed a new dual-use (civil and military) radionavigation system, the Global Positioning System (GPS). This system meets or exceeds the accuracy and coverage of many other radionavigation systems. Consequently, as the full civil potential of GPS is realized, the Federal Government expects to phase out radionavigation systems that no longer will be required.

Decisions to discontinue Federal operation of existing systems will depend upon many factors including: (a) resolution of GPS accuracy, coverage, integrity, financial, and institutional issues; (b) determination that the resulting systems mix meets civil and military needs currently met by existing systems; (c) availability of civil user equipment at economically acceptable prices; (d) establishment of a suitable transition period based on user equipment and acceptance, budgetary considerations, and the public interest, and (e) resolution of international commitments.

Although radionavigation systems are established primarily for safety of transportation, they also provide significant benefits to positioning and timing users. In recognition of this, any changes to Federal operation of radionavigation systems will consider these needs.

Radionavigation systems operated by the U.S. Government will be available subject to direction by the National Command Authority (NCA)

because of a real or potential threat of war or impairment to national security. Radionavigation systems will be operated as long as the U.S. and its allies accrue greater military benefit than do adversaries. Operating agencies may cease operations or change characteristics and signal formats of radionavigation systems during a dire national emergency. All licensed communication links, including those used to transmit differential GPS corrections and other GPS augmentations, are also subject to the direction of the NCA.

Individual System Plans:

GPS: GPS, a satellite-based radionavigation system operated by the DOD and jointly managed by the DOD and the DOT, provides two levels of service—a Standard Positioning Service (SPS) and a Precise Positioning Service (PPS). SPS will be available to all users on a continuous, worldwide basis, for the foreseeable future, free of any direct user charge. The specific capabilities provided by SPS are established by DOD and DOT and are published in the Global Positioning System Standard Positioning Service Signal Specification, available through the U.S. Coast Guard (USCG) Navigation Information Service. PPS, the most accurate service directly available from GPS without augmentation, is available to U.S. and allied military and U.S. Federal Government users. Limited non-Federal Government, civil use of PPS, both domestic and foreign, will be considered upon request and authorized on a case-by-case basis, provided:

- ◆ It is in the U.S. national interest to do so.
- ◆ Specific GPS security requirements can be met by the applicant.
- ◆ A reasonable alternative to the use of PPS is not available.

Augmentations to GPS:

When augmented to satisfy civil requirements for accuracy, coverage, and integrity, GPS will be the primary Federally provided radionavigation system for the foreseeable future.

In December 1993, the Joint DOD/DOT Task Force on GPS recommended a study of all augmented GPS services under deployment or development to determine the optimum integrated approach to providing augmented GPS services. In response to this recommendation, DOT and DOD undertook a study in 1994 to evaluate the capabilities of

various means of augmenting GPS and to determine the optimum integrated system for meeting the requirements of Federal land, marine, aviation, and space users. Recommendations from this study are currently under evaluation.

Augmentations to GPS are enhancements of the basic GPS system to meet unique requirements. Augmentations to GPS fall into three categories: 1) differential GPS (DGPS), 2) GPS integrity broadcasts (GIB), and 3) additional inputs from non-GPS navigation systems, equipment, or techniques.

DOD and DOT will not constrain the use of SPS-based differential GPS services as long as applicable U.S. statutes and international agreements are adhered to.

Maritime DGPS: The USCG is establishing DGPS service for the harbor and harbor approach phase of maritime navigation, as well as for navigation on the Great Lakes and western rivers. Maritime DGPS will use fixed GPS reference stations which will broadcast pseudo-range corrections using maritime radiobeacons. The USCG DGPS system is expected to provide radionavigation accuracy better than 10 meters (2 drms) for U.S. harbor and harbor approach areas by 1996. Until the DGPS service is declared operational by the USCG, users are cautioned that signal availability and accuracy are subject to change due to testing of this developing service and the uncertain reliability of prototype equipment.

Aeronautical Augmentations to GPS/SPS: The Federal Aviation Administration (FAA), in cooperation with other DOT organizations and DOD, is planning to augment the GPS/SPS with both a wide area and a local area system. The Wide Area Augmentation System (WAAS) can provide the required accuracy, integrity, and availability to be the primary means of navigation for all phases of flight from en route to Category I approaches. The Local Area Augmentation System (LAAS) may provide the required accuracy, integrity, and availability for Category II and Category III precision approaches. The Special Category I (SCAT-I) system will provide the required Category I service for private users.

Loran-C:

Loran-C provides radionavigation coverage for maritime navigation in U.S. coastal areas. It provides navigation, location, and timing services for both civil and military air, land and marine users. Loran-C is approved as a supplemental air navigation system and also serves a large number of users that operate under Visual Flight Rules (VFR). The Loran-C system serves the 48 conterminous states, their coastal areas, and

certain parts of Alaska. The system is expected to remain part of the radionavigation mix until the year 2000, to accommodate the transition to GPS. Continued operation after that date will depend on validating requirements for Loran-C that cannot be met by GPS or another system.

The DOD requirement for the Loran-C system ended December 31, 1994. Operations conducted by the USCG at overseas stations were phased out by the end of 1994.

Omega:

Omega provides global radionavigation coverage and primarily serves maritime, aviation, and weather users. The U.S. operates Omega under bilateral agreements with six partner nations (Norway, Liberia, France, Argentina, Australia, and Japan). The U.S. expects to continue Omega operations until September 30, 1997, to accommodate the transition of civil aviation users to GPS. Continued operation after that date will depend upon validating requirements for Omega that cannot be met by GPS or another system.

The DOD requirement ended December 31, 1994; however, limited Service use is expected while the system remains operational.

VOR/DME:

VOR/DME provides users with the primary means of air navigation in the National Airspace System (NAS). VOR/DME will remain the primary means of navigation for the en route through nonprecision approach phases of flight until GPS is approved to meet the Required Navigation Performance (RNP) for these phases of flight and the GPS WAAS is approved as a primary means of navigation. The current International Civil Aviation Organization (ICAO) protection date for VOR/DME is January 1, 1998. The phaseout of VOR/DME from the NAS is expected to begin in 2005 and to be complete by 2010.

The DOD requirement for and use of VOR/DME will terminate when aircraft are properly integrated with GPS and when GPS is certified by the DOD to meet RNP for national and international controlled airspace. The target date is the year 2000.

TACAN:

TACAN is the military counterpart of VOR/DME. The DOD requirement for and use of land-based TACAN will terminate when aircraft are properly integrated with GPS and when GPS is certified by the DOD to meet RNP in national and international controlled airspace. The target date to begin TACAN phaseout is the year 2000. Individual proposals for decommissioning of FAA-maintained TACANs prior to this date will be

assessed and approved on a case-by-case basis after an evaluation of operational requirements.

**Precision
Landing
Systems:**

The Instrument Landing System (ILS) serves as the standard for civil precision approach systems in the U.S. and abroad. It will remain the standard for Category I precision approaches until replaced by GPS-based service. WAAS Category I approaches are expected to be introduced into the NAS in 1997 and to become a primary service in 2001. Dual ILS and WAAS service will be provided for a transition period to allow users to equip with WAAS receivers and to become comfortable with its service. The phaseout of Category I ILS is then expected to begin in 2005 and to be complete by 2010.

For Category II and III precision approaches, test results show that a GPS-based system promises to more-affordably deliver this level of service than ILS. Based on these results, GPS-based Category II/III systems are anticipated to be introduced into the NAS by 2001, collocated at existing ILS Category II/III sites. The phaseout of Category II/III ILS from the NAS is then expected to begin in 2005 and to be complete by 2010.

Previous analysis done by the international community and in the U.S. resulted in ICAO selecting the Microwave Landing System (MLS) as the new international standard for precision approach systems. This selection was made before GPS was operational and before its potential to deliver precision approaches was explored. The U.S. is now working with ICAO Member States to change this guidance, and expects a revision to the current recommendation which calls for the phaseout of ILS in favor of MLS. The U.S. will continue to promote the international acceptance and implementation of GPS for navigation in all phases of flight. The FAA has terminated the development of MLS based on favorable GPS test results and budgetary constraints. The U.S. does not anticipate installing additional MLS equipment in the NAS, but could purchase systems on the open market for Category II/III operations if the need should arise in the future.

Transit:

Transit is a satellite-based positioning system operated by DOD. Transit will terminate and system operation will be discontinued no later than December 31, 1996.

Radiobeacons: Maritime and aeronautical radiobeacons serve the civilian user community with low-cost navigation. Selected maritime radiobeacons are being modified to carry differential GPS correction signals. This may cause these maritime radiobeacons to be unusable by certain aeronautical receivers. Maritime radiobeacons not used for DGPS may be phased out by the year 2000. Many of the functions of the aeronautical nondirectional beacon (NDB) are now being provided by GPS. Many NDBs that provide redundant service will begin to be phased out in the year 2000 with most NDBs expected to be decommissioned by 2005.

1.7 DOD Responsibilities

DOD is responsible for developing, testing, evaluating, operating, and maintaining aids to navigation and user equipment required for national defense, and for ensuring that military vehicles operating in consonance with civil vehicles have the necessary navigational capabilities. Specific DOD responsibilities are to:

- a. Define performance requirements applicable to military mission needs.
- b. Design, develop, and evaluate systems and equipment to ensure cost-effective performance.
- c. Maintain liaison with other government research and development activities affecting military radionavigation systems.
- d. Develop forecasts and analyses as needed to support the requirements for future military missions.
- e. Develop plans, activities, and goals related to military mission needs.
- f. Define and acquire the necessary resources to accomplish mission requirements.
- g. Identify special military route and airspace requirements.
- h. Foster standardization and interoperability of systems with North Atlantic Treaty Organization (NATO) and other friendly countries.
- i. Operate and maintain ground radionavigation aids as part of the NAS when such activity is economically beneficial and specifically agreed to by the appropriate DOD and DOT agencies.
- j. Derive and maintain astronomical and atomic standards of time and time interval, and to disseminate these data.

The Defense Mapping Agency (DMA) is responsible for military mapping, charting, and geodesy aspects of navigation, including geodetic surveys, accuracy determination, and positioning. Within DOD, DMA acts as the primary point of contact with the civil community on matters relating to geodetic uses of navigation systems. Unclassified data prepared by the DMA are available to the civil sector.

The U.S. Naval Observatory (USNO) is responsible for determining the positions and motions of celestial bodies, the motions of the Earth and precise time; for providing the astronomical and timing data required by the Navy and other components of DOD and the general public for navigation, precise positioning, and command, control and communications; and for making these data available to other government agencies and to the general public.

The USNO role as the nation's time standard was stated most recently in the National Defense Authorization Act FY92 and 93 Report, page 50. "The Department of the Navy serves as the country's official time keeper, with the master clock facility at the Washington Naval Observatory."

DOD carries out its responsibilities for radionavigation coordination through the internal management structure shown in Figure 1-2. The two major parts of the structure represent the administrative and the operational chains of command reporting to the Secretary of Defense.

1.7.1 Operational Management

The President or the Secretary of Defense, with the approval of the President, is the National Command Authority. The Chairman, Joint Chiefs of Staff (CJCS), supported by the Joint Staff, is the primary military advisor to the National Command Authority. The Service Chiefs provide guidance to their military departments in the preparation of their respective detailed navigation plans. The JCS are aware of operational navigation requirements and capabilities of the Unified Commands and the Services, and are responsible for the development, approval, and dissemination of the CJCS Master Navigation Plan (MNP).

The MNP is the official navigation policy and planning document of the CJCS. It is a coordinated navigation system plan which addresses operational defense requirements.

The following organizations also perform navigation management functions:

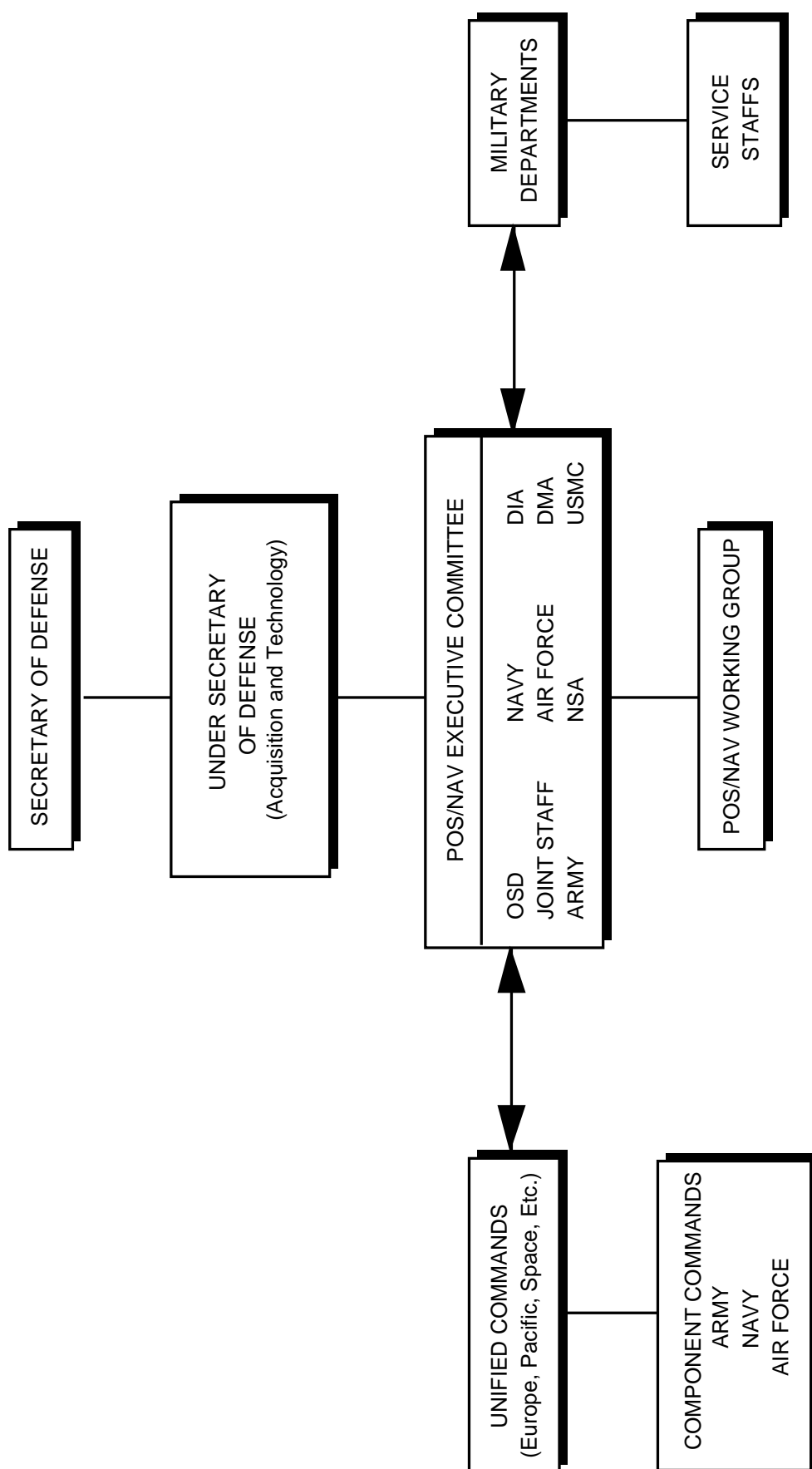
The Deputy Director for Defense-Wide Command, Control and Communications Support, Joint Staff, is responsible for:

- ◆ Analysis, evaluation, and monitoring of navigation system planning and operations.
- ◆ General navigation matters and the CJCS MNP.

The Commanders of the Unified Commands perform navigation functions similar to those of the JCS. They develop navigation requirements as necessary for contingency plans and JCS exercises that require navigation resources external to that command. They are also responsible for review and compliance with the CJCS MNP.

1.7.2 Administrative Management

Three permanent organizations provide radionavigation planning and management support to the Under Secretary of Defense for Acquisition and Technology (USD/A&T). These organizations are the POS/NAV Executive Committee; the POS/NAV Working Group; and the Military Departments/ Service Staffs. Brief descriptions are provided below.



The DOD POS/NAV Executive Committee is the DOD focal point and forum for all DOD POS/NAV matters. It provides overall management supervision and decision processes, including intelligence requirements (in coordination with the Defense Intelligence Agency and the National Security Agency). The Executive Committee contributes to the development of the FRP and coordinates with the DOT POS/NAV Executive Committee.

The DOD POS/NAV Working Group supports the Executive Committee in carrying out its responsibilities. It is composed of representatives from the same DOD components as the Executive Committee. The Working Group identifies and analyzes problem areas and issues, participates with the DOT POS/NAV Working Group in the revision of the FRP, and submits recommendations to the Executive Committee.

The Military Departments/Service Staffs are responsible for participating in the development, dissemination and implementation of the CJCS MNP and for managing the development, deployment, operation, and support of designated navigation systems.

A special committee, the GPS Phase-In Steering Committee, has been established to guide the development and implementation of the policies, procedures, support requirements, and other actions necessary to effectively phase GPS into the military operational forces.

1.8 DOT Responsibilities

DOT is the primary government provider of aids to navigation used by the civil community and of certain systems used by the military. It is responsible for the preparation and promulgation of radionavigation plans in the civilian sector of the United States. DOT carries out its responsibilities for civil radionavigation systems planning through the internal management structure shown in Figure 1-3. The structure was originally established by DOT Order 1120.32 (April 27, 1979) and revised by DOT Order 1120.32C (October 11, 1994) for the following purposes:

- a. To provide an organizational structure that will facilitate the coordination of policy recommendations and integrated planning regarding navigation and positioning among the operating elements of DOT, to help assure the most efficient implementation of these policies and plans, and to help ensure the most effective use of resources of the DOT operating elements (i.e., help avoid duplication of effort).
- b. To provide a management level body which can, on a continuing basis, facilitate coordination of navigation and positioning planning on a multimodal basis within DOT, and to serve as a focal point for recommendations on which DOT navigation and positioning policies and plans can be formulated.

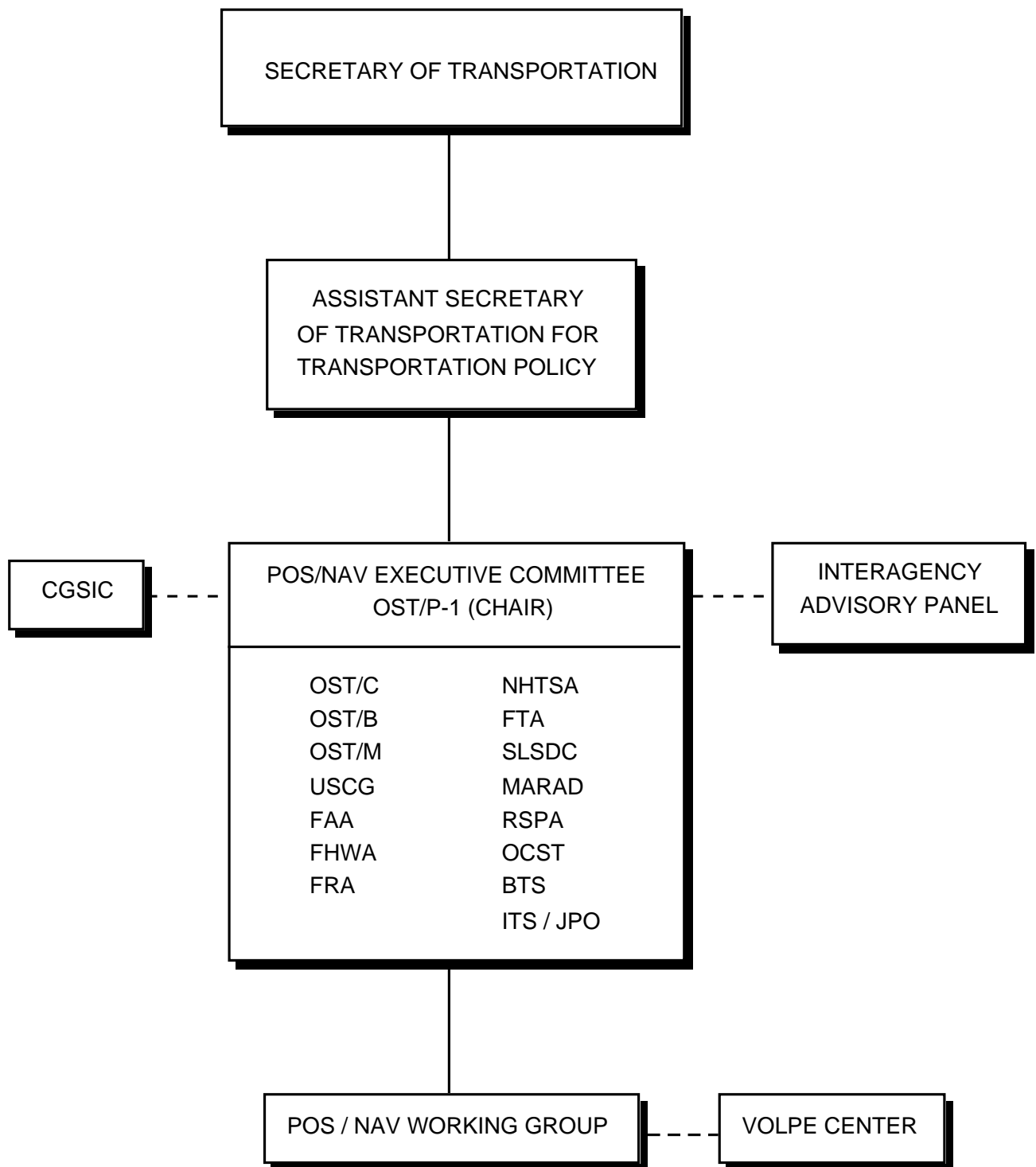


Figure 1-3. DOT Navigation Management Structure

- c. To assure that the Secretary of Transportation receives consolidated information; and to provide the means to obtain a coordinated high-level review of proposed navigation and positioning policies and plans.
- d. To establish a planning framework wherein the DOT operating elements are allowed maximum latitude for navigation and positioning system research, development, and implementation, consistent with OST/P policy guidance and the need to avoid duplication of effort.
- e. To provide the technical resources and appropriate management structure to supplement navigation and positioning planning, implementation, coordination, and decision making of the operating elements.
- f. To provide a focal point for obtaining inputs from those elements of DOT which may not have a continuous interest in navigation and positioning issues.
- g. To provide a DOT focal point for multimodal or inter-departmental navigation and positioning issues.
- h. To provide liaison with DOD.
- i. To coordinate DOT activities aimed at promoting international acceptance of U.S. radionavigation systems and supporting U.S. radionavigation and positioning manufacturing and service industries.

The DOT POS/NAV Executive Committee is the top-level management body of the organizational structure. It is chaired by the OST/P, and consists of policy level representatives from the General Counsel's Office (OST/C), the Office of the Assistant Secretary for Budget and Programs (OST/B), the Assistant Secretary for Administration (OST/M), USCG, FAA, FHWA, FRA, NHTSA, FTA, SLSDC, MARAD, RSPA, OCST, BTS, and ITS-JPO. The DOT POS/NAV Executive Committee:

- (1) serves as the focal point to formulate coordinated policy recommendations to the Secretary;
- (2) provides policy and planning guidance to the Department's operating administrations on navigation and positioning matters;
- (3) attempts to resolve any multimodal navigation and positioning issues that cannot be resolved by the POS/NAV Working Group;
- (4) is the focal point for coordination with similar committees in other government agencies;
- (5) provides unified Departmental comments on the proposed rulemakings of other governmental agencies in regard to radionavigation and positioning and related matters; and

- (6) provides guidance to the POS/NAV Working Group.

The POS/NAV Working Group is the staff working core of the organizational structure. It will be chaired by the OST/P Program Manager and will consist of one representative each from OST/C, OST/B, OST/M, USCG, FAA, FHWA, FRA, NHTSA, FTA, SLSDC, MARAD, RSPA, OCST, BTS, the Volpe National Transportation Systems Center (Volpe Center), ITS-JPO, and other DOT element representatives as necessary. Each representative may be assisted by advisors. The Center for Navigation, Volpe Center, also provides technical assistance to the POS/NAV Working Group. The Working Group shall facilitate the coordination of:

- (1) navigation and positioning requirements developed by the DOT operating elements;
- (2) navigation and positioning plans;
- (3) navigation and positioning R&D (research and development) and implementation programs;
- (4) DOT navigation and positioning planning with the Department of Defense, the Department of Commerce (DOC), the National Aeronautics and Space Administration (NASA), the Federal Geographic Data Committee (FGDC), and other Federal agencies, as required;
- (5) multimodal navigation and positioning issues with other governmental agencies, industry, and user groups, as directed by the POS/NAV Executive Committee; and
- (6) Department comments on the proposed rulemakings of other governmental agencies in regard to radionavigation and positioning and related matters.

The operating elements within DOT, as appropriate with their mission, shall:

- (1) assess, analyze, and document navigation and positioning requirements;
- (2) conduct the necessary research and development on navigation and positioning systems having potential application to their operation;
- (3) implement navigation and positioning systems needed to carry out their responsibilities to the public in a cost-effective manner, and participate with other DOT agencies in implementation of common-use systems;
- (4) retain existing responsibilities, under policy guidance from OST/P, for direct coordination with DOD on matters related to specific navigation and positioning systems operated by the individual elements of DOT; and

- (5) retain existing responsibilities, under policy guidance from OST/P, for international coordination on navigation and positioning matters for their appropriate transportation mode.

The Secretary of Transportation, under 49 U.S.C. 301, has overall leadership responsibility for navigational matters within DOT and promulgates radionavigation plans. Three DOT elements have statutory responsibilities for providing aids to navigation: the USCG, the FAA, and the SLSDC. In addition, several other elements of DOT and NASA have responsibilities and interests which may be satisfied by radionavigation or radiolocation systems.

OST/P coordinates radionavigation issues and planning which affect multiple modes of transportation, including those that are intermodal in nature. OST/P also interfaces with agencies outside of DOT on non-transportation uses of radionavigation systems.

The USCG defines the need for, and provides, aids to navigation and facilities required for safe and efficient navigation. Section 81 of Title 14, U.S.C. states the following:

“In order to aid navigation and to prevent disasters, collisions, and wrecks of vessels and aircraft, the Coast Guard may establish, maintain, and operate:

- (1) aids to maritime navigation required to serve the needs of the armed forces or of the commerce of the United States;
- (2) aids to air navigation required to serve the needs of the armed forces of the United States peculiar to warfare and primarily of military concern as determined by the Secretary of Defense or the Secretary of any department within the Department of Defense and as requested by any of those officials; and
- (3) electronic aids to navigation systems (a) required to serve the needs of the armed forces of the United States peculiar to warfare and primarily of military concern as determined by the Secretary of Defense or any department within the Department of Defense; or (b) required to serve the needs of the maritime commerce of the United States; or (c) required to serve the needs of the air commerce of the United States as requested by the Administrator of the Federal Aviation Administration.

These aids to navigation other than electronic aids to navigation systems shall be established and operated only within the United States, the waters above the Continental Shelf, the territories and possessions of the United States, the Trust Territory of the Pacific Islands, and beyond the territorial jurisdiction of the United States at places where naval or military bases of the United States are or may be located. The Coast Guard may establish, maintain, and operate aids to marine navigation under paragraph (1) of this section by contract with any person, public body, or instrumentality."

The FAA has responsibility for development and implementation of radionavigation systems to meet the needs of all civil and military aviation, except for those needs of military agencies which are peculiar to air warfare and primarily of military concern. FAA also has the responsibility to operate aids to air navigation required by international treaties.

MARAD investigates position determination using existing and planned navigation systems, conducts precision navigation experiments, and investigates the application of advanced technologies for navigation and collision avoidance. These efforts are designed to enhance U.S. Merchant Marine efficiency and effectiveness.

The SLSDC has responsibility for assuring safe navigation along the St. Lawrence Seaway. The SLSDC provides navigational aids in U.S. waters in the St. Lawrence River and operates a Vessel Traffic Control System with the St. Lawrence Seaway Authority of Canada.

FHWA, NHTSA, FRA, FTA, and RSPA have the responsibility to conduct research, development, and demonstration projects, including projects on land uses of radiolocation systems. They also assist state and local governments in planning and implementing such systems and issue guidelines concerning their potential use and applications.

The OCST is charged with: (1) promoting, encouraging, and facilitating commercial space transportation by the U.S. private sector; and (2) ensuring public safety with respect to commercial space transportation, operation of launch sites and spaceports by the U.S. private sector, and commercial satellites not otherwise licensed by another Federal agency. Accordingly, OCST is interested in the demand for space launches by providers of satellite-based services including radiodetermination.

NASA supports navigation through the development of technologies for navigating aircraft and spacecraft. NASA is responsible for development of user and ground-based equipment, and is also authorized to demonstrate the capability of military navigational satellite systems for civil aircraft, ship, and spacecraft navigation and position determination.

1.9 DOD/DOT Joint Responsibilities

A Memorandum of Agreement (MOA) between DOD and DOT for radionavigation planning became effective in 1979; it was updated in 1984, 1990, and 1994. This agreement requires coordination between the DOD and DOT internal management structures for navigation planning and establishes a GPS Executive Board chaired by DOD (USD/A&T) and DOT (OST/P). The MOA recognizes that DOD and DOT have joint responsibility to avoid unnecessary overlap or gaps between military and civil radionavigation systems and services. Furthermore, it requires that both military

and civil needs be met in a manner cost-effective for the Government and civil user community.

Implicit in this joint responsibility is assurance of civil sector radionavigation readiness for mobilization in national emergencies. The agreement provides that DOD and DOT will jointly:

- ◆ Inform each other of the development, evaluation, installation, and operation of radio aids to navigation with existing or potential joint applications.
- ◆ Coordinate all major radionavigation planning activities to ensure consistency while meeting diverse navigational requirements.
- ◆ Attempt, where consistent with diverse requirements, to utilize common systems, equipment, and procedures.
- ◆ Undertake joint programs in the research, development, design, testing, and operation of radionavigation systems.
- ◆ Prepare a standard definition of requirements and a joint requirements document (FRP).
- ◆ Assist in informing or consulting with other government agencies involved in navigation system research, development, operation, or use, as necessary.
- ◆ Publish a single DOD/DOT FRP to be implemented by internal departmental actions. This plan will be reviewed and updated biennially.

1.10 Determination of Future Radionavigation Systems Mix

Many factors determine the choice of the systems mix to satisfy diverse user requirements. They may be categorized according to operational, technical, economic, institutional and international parameters. System accuracy and coverage are the foremost technical parameters, followed by system availability and reliability. Certain unique parameters, such as anti-jamming performance, apply to military needs.

The current investment in ground and user equipment must also be considered. In some cases, there may be international commitments which must be honored or modified in a fashion mutually agreeable to all parties.

In most cases, current systems were developed to meet distinct and different requirements, and they will be retained until such needs no longer exist or can be met by an acceptable systems mix. This development of systems to meet unique

requirements led to the development of multiple radionavigation systems and was the impetus for early radionavigation planning. The first edition of the FRP was published to plan the mix of radionavigation systems and promote an orderly life cycle for them. It described an approach for selecting radionavigation systems to be used in the future. Early editions of the FRP, including the 1984 edition, reflected that approach with minor modifications to the timing of events. By 1986, it became apparent that a final recommendation on the future mix of radionavigation systems was not appropriate and major changes to the timing of system life-cycle events were required. Consequently, it was decided that starting with the 1986 FRP, a current recommendation on the future mix of radionavigation systems would be issued with each edition of the FRP. This current recommendation reflects dynamic radionavigation technology, changing user profiles, and input received at radionavigation user conferences sponsored by DOT and DOD.

1.10.1 Approach to Systems Mix

There are long-term and short-term aspects that need to be addressed in the overall selection process. The long-term goal is to establish, through an integrated DOD and DOT planning and budgeting process, a cost-effective, user-sensitive mix of systems for the post-2000 time frame. As part of this long-term goal, until it can be clearly established which civil requirements being met by existing systems can be met by GPS, there may be a need to improve or expand existing systems. The selection process for the systems to be used in the future allows the flexibility to adopt incremental improvements where justified over the short term. Similarly, the process permits system upgrading and research and development to allow the satisfaction of operational requirements which are not met by existing or planned systems. An example was the combined effort of the USCG and the FAA to provide mid-continent Loran-C coverage.

Figure 1-4 shows the process for selecting the Federally provided radionavigation systems to be used in the future. It is recognized that GPS may not meet the needs of all civil users of radionavigation systems. Therefore, some system life cycles are independent of the GPS implementation date. After the ability of GPS to meet user needs has been verified, systems it would potentially replace will be reviewed for future requirements or phase-out.

DOT will maintain liaison with the civil users of radionavigation systems through user conferences or other appropriate means prior to updating the FRP. Input received will become a vital part of the biennial decision-making process on radionavigation system life cycles. This consultation, review, and recommendation cycle will be continued until the ability of GPS to meet civil user needs has been determined. At that time, long-term phase-out or phase-over plans will be considered for those systems replaceable by GPS. During 1995, international, intragovernmental, and user consultations will take place on the future of Federally provided radionavigation systems. Developments in GPS augmentations and the

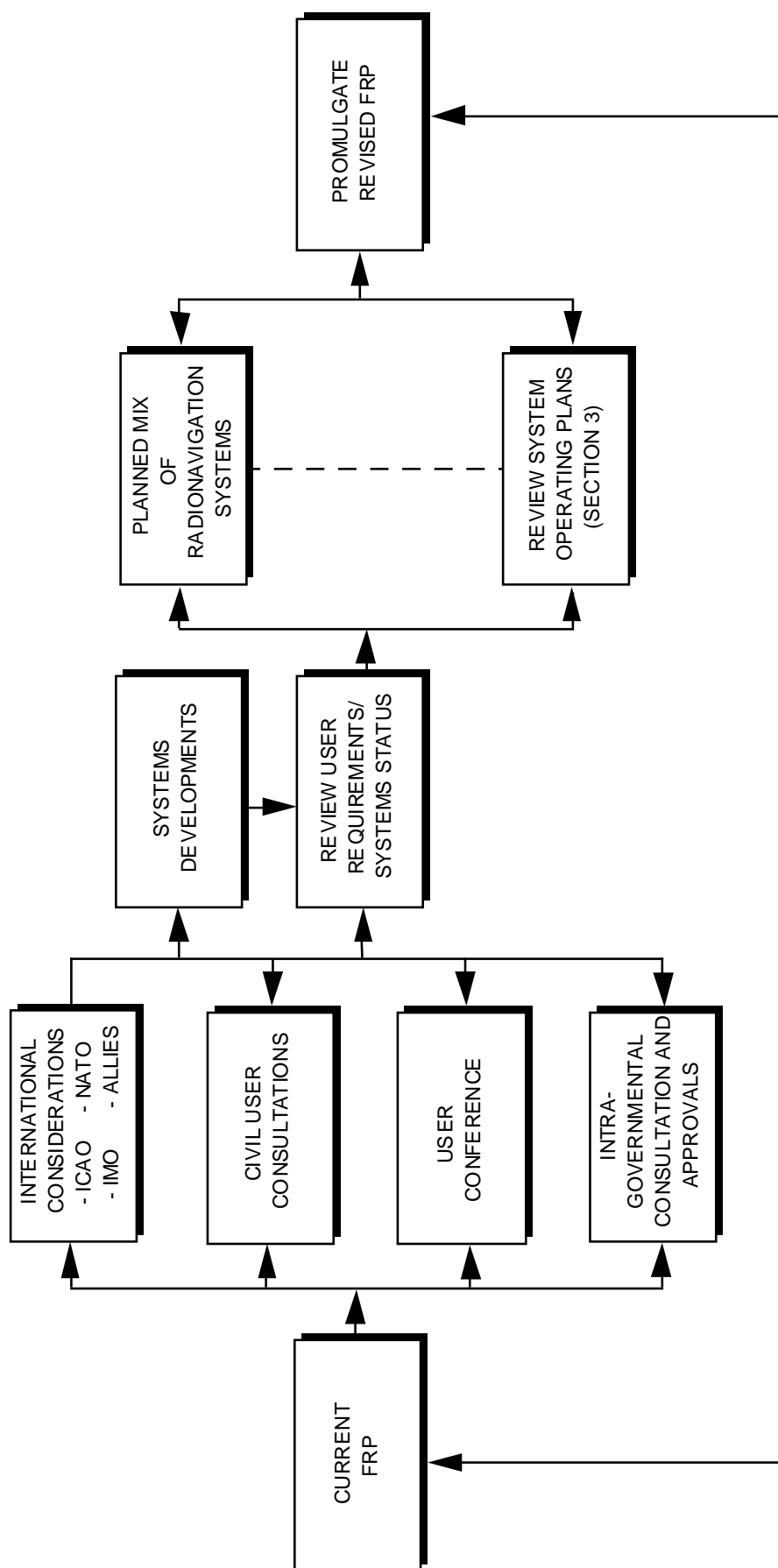


Figure 1-4. DOD/DOT Radionavigation Systems Planning Process

changing needs of civil users will be reviewed. The status and impact of commercial systems will also be considered as a part of this process. In addition, as an alternative to the phasing out of civil radionavigation systems, consideration will be given to the possibility of phasing over their operation to the private sector.

At that point in time when the need or economic justification for a particular system appears to be waning, the Department operating the system will provide notification to the appropriate Federal agencies and to the public, by publication in the Federal Register, of the proposed discontinuance of service and will seek public comment. The Final Rule will be issued only after consideration of all comments received.

For each common-use system, the following process is used to select systems to be part of the future radionavigation systems mix. DOT will evaluate civil requirements for a system including requirements for redundancy and, if needed, the system will be retained as part of the systems mix. Evaluating civil user requirements and determining a cost-effective mix of systems requires an open dialogue with civil users and international organizations, such as IMO and ICAO. It also requires a review of U.S. international commitments and resolution of any conflicts. DOD decides whether a given system is necessary to meet military requirements and if so, the system will be retained as part of the systems mix. An intensive effort is necessary and desirable to establish a stable framework for long-range planning by users and others affected by the transition to a new combination of systems. Consideration of operational, technical, economic, and institutional issues will dominate this selection process. However, the goal is to meet all military and civil requirements with the minimum number of common-use systems. Finally, a national policy will reflect: (1) national security requirements, (2) consultations with U.S. allies and civil users, and (3) DOD/DOT deliberations.

It must also be kept in mind that the provision of Government services for meeting user requirements is subject to the budgetary process, including authorizations and appropriations by Congress, and priorities for allocations among programs by agencies.

1.10.2 *Operational Issues*

Mobile users and operators want the safest, most direct, and most economical path to their destinations or, in some cases, the user wants to locate a fixed point or boundary. Users must be able to respond correctly and quickly to traffic control services. They must navigate with accuracy consistent with their environment, the capability of others sharing their space, the performance of their craft, and the rules, regulations, and procedures which govern operations. Areas of operation, mission, economics, personal preference, and Federal regulations largely determine the radionavigation aids chosen by operators. They choose different kinds of equipment to use the particular aid selected, and generally wish to limit or minimize the cost.

1.10.3 Special Military Considerations

A. Military Selection Factors

Operational need is the principal influence in the DOD selection process. Precise navigation is required for vehicles, anywhere on the surface of the Earth, under the sea, and in and above the atmosphere. Other factors that affect the selection process are:

- ◆ Flexibility to accommodate new weapon systems and technology.
- ◆ Immunity of systems to enemy interference or exploitation.
- ◆ Interoperability with the systems used by allies and the civil sector.
- ◆ Reliability and survivability in combat.
- ◆ Interruption, loss or degradation of system operation by enemy attack, political action, or natural causes.
- ◆ Development of alternate means of navigation.
- ◆ Geodetic accuracy relative to a common reference system, to support strategic and tactical operations.
- ◆ Worldwide mobility requirements.

B. Civil/Military Compatibility

DOD aircraft and ships operate in, and must be compatible with, civil environments. Thus, there are potential cost advantages in the development of common civil/military systems.

The activities experienced in activation of the maritime Ready Reserve Force during Desert Shield/Desert Storm have identified a potential need for improved navigation accuracy for ships involved in military sealift support. New GPS receiver concepts for systems with optional security modules are under consideration to be used when commercial ships are called into use in national emergencies.

C. Review and Validation

The DOD radionavigation system requirements review and validation process:

- ◆ Identifies the unique components of mission requirements.
- ◆ Identifies technological deficiencies.
- ◆ Determines, through interaction with DOT, the impact of new military requirements on the civil sector.

The requirements review and validation process will investigate system costs, user populations, and the relationship of candidate systems to other systems and functions.

1.10.4 *Technical Considerations*

In evaluating future radionavigation systems, there are a number of technical factors which must be considered:

- ◆ Received signal strength
- ◆ Multipath effects
- ◆ Signal accuracy
- ◆ Signal acquisition and tracking continuity
- ◆ Signal integrity
- ◆ Availability
- ◆ Vehicle dynamic effects
- ◆ Signal coverage
- ◆ Noise effects
- ◆ Propagation
- ◆ Interference effects (natural or man-made)
- ◆ Installation requirements
- ◆ Environmental effects
- ◆ Human factors engineering
- ◆ Reliability

1.10.5 *Economic Considerations*

The Government must continually review the costs and benefits of the navigation systems it provides. At the present time, there are several systems being operated by FAA, USCG, DOD and others. This continuing analysis can be used both for setting priorities for investment in new systems, and determining the appropriate mix of older systems to be retained. Only those systems that serve a significant number of users and provide the economic benefits in excess of costs should continue in operation. In some cases duplicate systems will have to be maintained for safety reasons and to allow adequate time for the transition to newer more accurate systems; however, older systems must be evaluated to determine whether or not their level of use is cost-effective.

The benefits from the Government operated navigation systems include improvements in economic productivity, operating efficiency, and accuracy in determining location. These factors allow planning for more fuel efficient routes and can prevent inadvertent diversions from the planned routes. Fuel savings can be in the billions of dollars. More precise location information can also be an important factor in preventing accidents. The efficiency benefits generally are the largest in dollar terms, but the safety benefits are very significant in justifying navigation systems.

The costs of navigation systems include capital investment, operating costs, and maintenance. These costs are borne by both the Government and the user. For new or replacement systems, the capital costs are significant. For existing systems, the operating and maintenance costs are the most important. Obtaining valid cost estimates is critical to analyzing the need for navigation systems.

Life cycle cost analysis is another important tool in decisions on navigation systems. When information is available on the actual operating and maintenance costs for a system, the life cycle cost analysis is very important in choosing between competing systems. Both DOD and DOT are increasingly aware of the need to minimize the life cycle costs in order to ensure the continued operation of navigation systems.

1.10.6 Institutional Considerations

The Department of Transportation Strategic Plan supports implementing GPS as the world's standard in the air, on land and over water. In order to accomplish this, there is a need to work with Congress, and all other interested parties, to develop a comprehensive, continuing and reliable funding program for the transportation navigation and positioning infrastructure.

A. Cost Recovery for Radionavigation Services

Use of present Federal radionavigation services cannot be easily measured; therefore, it would be difficult to assess direct user charges. Direct user charges normally involve a fee for each use of a specific system. Cost recovery for radionavigation services is either through general tax revenues or through transportation trust funds which are generally financed with indirect fees. These fees usually take the form of a fuel tax or value-added tax and can be used to pay all or part of an agency's costs.

It has been the general policy of the U.S. Government to recover the costs of Federally provided services that provide benefits to specific user groups. DOT plans to conduct a detailed analysis of costs and cost recovery mechanisms. Using existing user tax mechanisms, perhaps with some adjustments in rates to more equitably distribute the burden among different user groups, would be an efficient way of implementing a cost recovery policy.

At this point, the DOD-operated systems such as GPS are financed with general tax revenues. The USCG-operated systems are also operated with general tax revenues, although some amount of USCG outlays are offset by commercial vessel tonnage taxes. Aviation navigation systems are purchased with trust fund revenues and the systems are operated with a mix of general tax funds and trust funds. Introduction of GPS services will greatly increase the number of users to include automobiles, trains, transit, and land surveyors. The question is whether or not there is a better method for recovering the costs of GPS and other navigation systems that have widespread use. The Government will continue to study this issue.

B. Signal Availability in Times of National Emergency

The availability of accurate navigation signals at all times is essential for safe navigation. Conversely, guaranteed availability of optimum performance may diminish national security objectives, so that contingency planning is necessary. The U.S. national policy is that all radionavigation signals (Loran-C, Omega, VOR/DME, TACAN, GPS, augmented GPS, Transit, and radiobeacons) will be available at all times except during a dire national emergency as declared by the NCA, when only those radionavigation signals serving the national interest will be available.

C. International Acceptance of Navigational Systems

The goals of standardization and cost minimization of user equipment influence the search for an international consensus on a selection of radionavigation systems. For civil aviation, the ICAO establishes standards for internationally used radionavigation systems. For the international maritime community, a similar role is played by the IMO. Traditionally, IMO has been less stringent in establishing radionavigation requirements for the maritime community than ICAO has been for the aviation community. The IALA also develops international radionavigation guidelines. IMO is reviewing existing and proposed radionavigation systems to identify a system or systems that could meet the requirements of, and be acceptable to, members of the international maritime community.

In addition to technical and economic factors, national interests must also be considered in the determination of a system or systems to best meet the civil user's needs. Further international consultations will be required to resolve the issues.

D. Role of the Private Sector

Radionavigation services have historically been operated by the Government for reasons of safety and security, and to enhance commerce. These systems are used for air, land and marine applications, including navigation and positioning, and also for time and frequency dissemination.

For certain applications such as landing, positioning, and surveying, in areas where Federal systems are not justified, a number of privately operated systems are

available to the user as an alternative or adjunct service. One application of privately provided DGPS supports Special Category I (SCAT-I) precision approaches. SCAT-I approaches are specially authorized by the FAA to Category I weather minima with DGPS used to provide navigation guidance. The FAA uses appropriate airworthiness and operational approval processes, based upon an aircraft operator's demonstrated capability and equipment, as well as the availability of approved ground equipment. Several commercial concerns are now also offering DGPS services for positioning and surveying applications. All operators using licensed U.S. communications links to transmit DGPS corrections are subject to constraints as directed by the NCA.

There is current interest in an increased private sector role in Federally provided radionavigation systems. Some of the factors to be considered in examining increased private sector involvement include:

- ◆ Impact of privately operated services on usage and demand for Federally operated services.
- ◆ Impact of permitting privately operated systems to provide basic safety of navigation services in conjunction with communications services.
- ◆ Need for a Federally provided safety of navigation service if commercial services are available.
- ◆ Liability considerations.
- ◆ Consideration of phase-over to private operation as a viable alternative to phase-out of a Federally operated radionavigation service.

1.10.7 Criteria for Selection

Criteria have been defined to compare alternative radionavigation system configurations. At the minimum, future systems should meet the following selection criteria:

A. Service: Necessary service should be provided to meet the needs of the military and civil communities.

- ◆ Military Operations: At a minimum, radionavigation services to support accomplishment of DOD tactical and strategic missions should be provided in an effective and efficient manner.
- ◆ Transportation Safety: At a minimum, radionavigation services sufficient to allow safe transportation should be provided.

- ◆ Economic Efficiency: To the extent possible and consistent with cost-effectiveness, radionavigation services which benefit the economy should be provided.

B. Viability: Radionavigation systems should be responsive and flexible to the changing operational and technological environments.

- ◆ Evolving Technology: Research and introduction of new systems and concepts should be considered, particularly where unmet requirements or cost savings exist. Research, at the appropriate level, should continue for the life of the system.
- ◆ Orderly Transition: Modification and transition of systems should occur in an orderly manner to accommodate technical improvements.
- ◆ Flexibility: Radionavigation services should be provided to a variety of user classes with the minimum number of systems.
- ◆ Coverage: Radionavigation services should be provided in all relevant operating areas.

C. Standardization: A necessary degree of standardization and interoperability should be recognized and accommodated for both domestic and foreign operations.

- ◆ International Acceptance: Navigation services and systems should be technically and politically acceptable to diverse groups, including NATO and other allies, ICAO, International Telecommunications Union, and IMO.
- ◆ Civil/Military Interoperability: The basic capabilities to permit common use and common operational procedures by civil and military users should be provided.
- ◆ Equipment Standardization and Compatibility: Civil and military navigation equipment should be compatible to the extent feasible. In addition, the number of transmission formats should be kept to a minimum in meeting diverse civil requirements.

D. Costs: The required level of service should be achieved in an economical manner.

- ◆ Combined User/Government Costs: Life cycle costs of a mix of radionavigation systems for government and users should be consistent with adequate service and reasonable benefits.
- ◆ Transition Period Cost: Parallel (new and old) system operations should be carried out over a suitable transition period in consideration

of user investment cost penalties and to permit equipment replacement to occur at reasonable intervals.